Public Private Partnerships and economic growth in developing countries: An empirical analysis

A Dissertation

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by

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ABSTRACT

The study analysed the impact of Public Private Partnership (PPP) investment on economic growth in 39 developing countries, and used a traditional growth model. Using the system Generalised Method of Moments (GMM) estimation technique, the analysis was carried out in two ways. First, the study analysed the effect of total PPP investment on economic growth, measured in GDP per capita. Secondly, PPP investment was disaggregated into the three PPP sectors, namely energy, transport, and water and sanitation. This was done to identify the most productive sectors for PPP investment. This study used the World Bank's Private Participation in Infrastructure (PPI) database and covered a period between 1997 – 2016.

The findings suggest that PPP investment positively contributes to economic growth. When disaggregated by sector, the results of the study suggest that none of PPP investment in the selected sectors positively contribute to economic growth. PPP investment in the energy and transport sectors were found to contribute negatively to economic growth. In contrast, PPP investment in the water and sanitation sector was found to be insignificant when it comes to explaining economic growth in these countries.

The sectoral results of PPP investment were unexpected and could be attributed to limitations of data as some sectoral data was not reported on in the database. This finding points to the importance of data that is adequate and consistently available over a long period. PPPs are becoming a necessary solution for strengthening infrastructure and generating economic growth in developing countries. Thus, understanding the empirical links, through research, that exists between infrastructure investment using PPPs and economic growth, is essential.

Research such as these could enhance debate in developing countries on how best to use PPP models as propellers of economic growth. As such, how data is reported is important as it affects the credibility of the model and the results produced by it. It is therefore important that the shortcomings of inconsistency in the reporting of data be corrected to ensure that meaningful and accurate conclusions could be drawn from it.

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LIST OF ACRONYMS

AR (2)	Second Order Autocorrelation
DFI	Development Finance Institution
GCF	Gross Capital Formation
GDP	Gross Domestic Product
GDPPC	Gross Domestic Product per Capita
GMM	Generalised Methods of Moments
ICT	Information and Communication Technology
NPM	New Public Management
PPI	Private Participation in Infrastructure Investment
PPP	Public Private Partnership
SDG	Sustainable Development Goal
UK	United Kingdom
VAR	Vector Autoregression

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CHAPTER ONE
INTRODUCTION

1.1 Background of the study

It is estimated that between 2013 and 2030, developing countries will account for more than 90% of the global population (Consultancy.uk, 2015). This population requires access to energy, water and sanitation, telecommunication, education and health. To deal with these needs amidst the growing pressures of urbanisation and other economic development constraints, would require huge infra-structural projects.

When well planned, funded and maintained, a developed infrastructure could support a country's competitiveness, economic growth and improve its population's standard of living. On the flip side, access to affordable services is also important for the welfare of their respective economies. However, the traditional way of the government being the sole provider of the required infrastructure has been woefully inadequate to cater for the rising demand for infrastructure facilities.

One of the factors that hinder the expansion of public infrastructure is funding. The United Nations (2014) concluded that countries in the Sub-Saharan Africa region needed to invest US$93 billion annually to meet their respective development goals. However, actual investment wanly amounted to US$45 billion. This implies a funding gap of about US$50 billion per year. For the developing world, an estimated investment of US$836 billion annually or 6.1% of current gross domestic product (GDP) was required from 2014 to 2020 to meet new infrastructure demands and to maintain the current levels of services (World Bank Group, 2017). Therefore, the need for infrastructure far exceeds the financial resources currently available from the traditional ways of funding public infrastructure.

The traditional way of funding public infrastructure has been that that government provides investment for infrastructure in line with the inherent public-goods nature of infrastructure. However, government resources, especially in the developing economies, are increasingly becoming strained, with rising debt-to-GDP ratios and widening budget deficits (World Bank Group, 2017). Accordingly, as governments do not always have money to finance infrastructure investments, they are increasingly resorting to ways of mobilising the private sector in order to close this funding gap (Deloitte Research, 2006).

Private sector funding can be mobilised in a form of Public-Private Partnership (PPPs) models. This model of funding is increasingly gaining traction in the field of development finance. According to the World Bank's private participation in infrastructure investment (PPI) database (2017), PPP investments have increased significantly between 2001 and 2015 in developing countries, classified as low income, lower middle income, and upper middle income.[1]

The importance of infrastructure for economic growth is well documented. In fact, the establishment of the link between infrastructure and economic development dates back from the time when Aschauer (1989) was investigating the relationship between public infrastructure and economic growth. By using a cross-sectional state-level data, he found that a statistical relationship between infrastructure and economic growth exits.

A cross country panel study by Ganelli and Tervala (2016) also found that a rise in public infrastructure investment is positively linked with economic output. Moreover, using a traditional Solow growth model, Estache, Veredas, and Speciale (2005) argued that infrastructure matters for economic growth in Sub-Saharan Africa, mainly infrastructure in the telecoms and road sectors.

Empirically, the involvement of the private sector in providing public infrastructure and its impact on economic growth is not well resourced. Most available studies only analyse factors that determine the success of PPP investments (e.g. Babatunde et al., 2012; Basilio, 2017; Hammami, Ruhashyankiko, & Yehoue, 2006).

Analysing the involvement of private sector in providing public infrastructure, therefore, is important. While the private sector is regarded to be efficient in the way they provide infrastructure, they are generally more concerned with making profits. This is different from the motive of the public sector which is more to do with promoting efficiency within the economy through the multiplier effect that infrastructure has on the enhancement of economic growth. Combining the expertise of both the public and the private sectors in providing public infrastructure thus makes it necessary to investigate how the outcomes of such a partnership impacts on economic growth.

[1] The World Bank classifies these regions according to Gross National (GNI) Income per capita. Low income group refers to countries with a GNI per capita of US$1 025 or less in 2015, lower middle income countries are those with a GNI per capita of between US$1 026 and US$4 035, whilst upper middle income countries falls between US$4 046 and US$12 475.

This study uses the traditional growth model to investigate the effectiveness of PPP investment in providing public infrastructure in order to propel economic growth. Using the World Bank's PPI database, the study will focus on a sample of developing countries classified in its database, covering the period between 1997 – 2016. The specific objective of this study is to analyse the effects of PPP investment on economic growth in developing countries.

1.2 Problem Statement

The positive impact of increased public infrastructure investment on output is well recorded (Dintilhac, Ruiz-Nunez, & Wei, 2015; Estache & Garsous, 2012b; Estache et al., 2005). Ganelli and Tervala (2016) take the analysis a step further by investigating the impact of public infrastructure investment on domestic welfare. According to their analysis, if the infrastructure is sufficiently planned and managed, a US$1 spent on public infrastructure investment increases the domestic welfare by the equivalent of US$0.8 of private consumption.

Investment in public infrastructure is not only important for economic growth, but it is also crucial for the provision of and access to basic services such as electricity, water, sanitation and roads (Estache & Garsous, 2012b). However, due to various reasons including constrained budgets, high debt and fiscal deficits (Deloitte Research, 2006), governments in developing countries are constantly finding it challenging to finance public infrastructure that will keep up with a growing population and the increased pressure of urbanisation. Because of these pressures, governments, especially in developing countries, are increasingly partnering with the private sector for funding and operation of infrastructure projects in the form of PPPs (Deloitte Research, 2006). PPP models have become important for governments to narrow the existing infrastructure gap.

The concept of actively engaging the private sector in the provision of public goods is generally associated with the establishment of New Public Management (NPM) that was established in the United Kingdom in the 1980s (Ferk & Ferk, 2017). Included in the NPM were the concepts of "deregulation, privatisation and marketisation" (Ferk & Ferk, 2017). Since then, various developing countries, including China and India, have adopted the PPP model of public infrastructure development. In fact, Ferk and Ferk (2017) mention that amongst the developing countries, India has been one of the leading PPP markets, with over 800 projects reaching financial closure after 1990.

In other developing countries, particularly in Africa, the adoption of the PPP way of funding infrastructure is gaining traction, particularly for the development of both core economic and social infrastructure.[2] More important, the new 2030 Agenda for Sustainable Development in developing countries gives impetus to the role of PPPs in providing essential infrastructure that will be critical in achieving their Sustainable Development Goals (SDGs).

Hammami, Ruhashyankiko, and Yehoue (2006) claim that the partnership between public and private is driven by at least two motives. The private candidates are driven by the motive to make money by building the public infrastructure that would provide the necessary service delivery. On the other hand, the public sector is concerned with bridging the funding gap that would as far as possible, cushion it against fiscal shocks. However, as highlighted by Dintilhac et al. (2015) unfortunately, there are not many empirical studies that assess the impact of infrastructure investment through PPP models on economic growth and most studies are based on case studies evaluating particular projects (e.g. Tang, Shen, & Cheng, 2010 and Kwak, Chih, & Ibbs, 2009) rather than giving an overall robust empirical analysis of projects in general.

Therefore, it is important to assess if PPPs are the most effective way of funding public infrastructure that would enhance and support overall economic growth.

1.3 Research Objective

The basis and objective of this study are to examine the effects of PPPs on economic growth in selected developing countries and make an empirical analysis of the impact of PPPs on economic growth. More specifically, the objective is:

- To investigate the effects of total PPP investment on economic growth in developing countries
- To investigate which PPP- sectors have the most impact on economic growth.

1.4 Justification of Research

Besides the fact that private sector participation in infrastructure investment is necessary for closing the infrastructure funding gap and for improving operational efficiencies, there has been limited research on how private sector's involvement in providing public infrastructure, affects

[2] Mutambatsere (2017) classifies economic infrastructure as energy, water, transport and Information and Communication Technology (ICT) and social as health, education and social protection, among others.

economic growth on a whole. Such a type of study would be required to illustrate whether the involvement of the private sector indeed brings expertise, new technology, and efficiency on the operational side of the project and that these efficiency gains contribute towards economic growth in general.

In their research on the economic impact of infrastructure and private sector participation, Dintilhac et al. (2015) highlight the fact that in some infrastructure projects, the involvement of the private sector may lead to a change in the tariff structure of any particular service. In those instances where the tariff had historically been kept artificially low, the new investment and participation of the private sector necessitated an increase in the tariff level in order to restore the financial sustainability of the investment on a whole. In such a case, the involvement of the private sector may negatively affect accessibility (Dintilhac et al., 2015). In contrast, viewed from a macroeconomic level, the economic growth generated by the participation of the private sector may have indirect benefits for the poor. Therefore, it is important to understand how the participation of the private sector, particularly in the developing world, had affected the economic development of these countries.

1.5 Organization of the study

The proceeding chapters are organised as follows:

- Chapter 2 reviews the literature on how PPPs affect economic growth, discussing some theoretical aspects of this topic.
- Chapter 3 focuses on the methodology used in answering the question, describing the data used and sources as well as estimation techniques.
- Chapter 4 discusses and summarises estimation results.
- Chapter 5 concludes the study and provide some recommendations.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

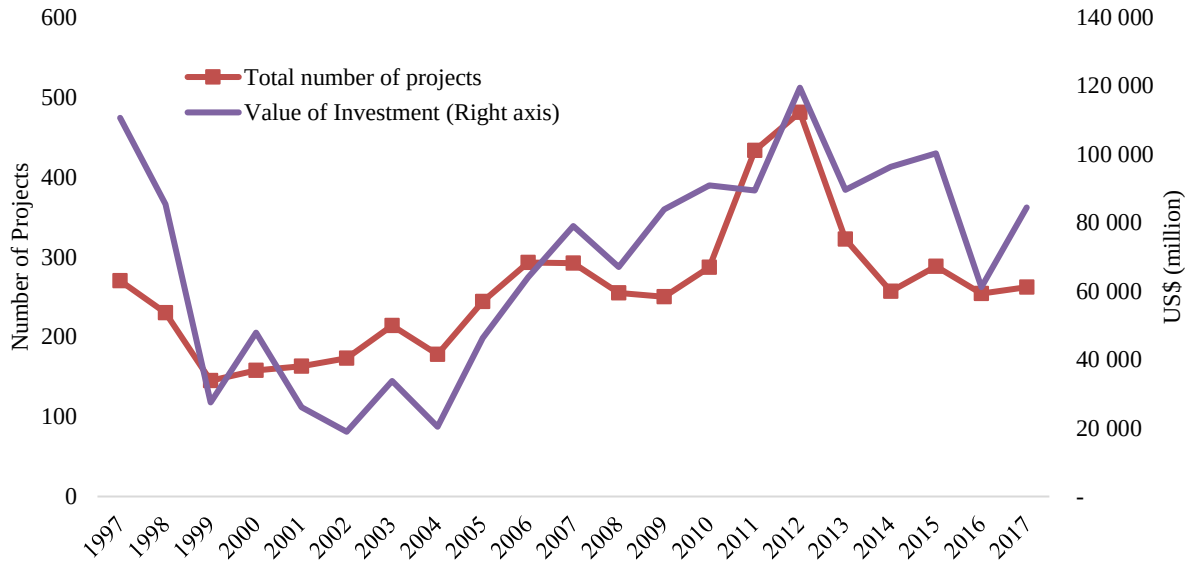
Chapter 2 is structured as follows:

- Sections 2.2 provides an overview of PPPs in developing countries as outlined in Table A1 of the Annexure.
- Section 2.3 looks at the theoretical framework of PPPs and this is followed by
- Section 2.4, which analysis existing emprical studies on PPPs and economic growth.
- Section 2.5 provides a summary of empirical studies.

2.2 Overview of Public Private Partnerships in Developing Countries

In this section, data is used from the World Bank's PPI project database over the period 1994-2017 to analyse trends in PPPs in developing countries. This analysis focuses on PPP projects that had reached financial closure over the period being reviewed. The analysis only includes data available of a certain number of projects and the value of the investment into such projects over an analysed period. The values represent committed investment and not necessarily actual expenditure as some of the commitments may have been cancelled or distressed over the analysed period.

Figure 1: Total Investment Commitments in Developing Countries from 1997 to 2017



Source: Data from World Bank's Private Participation in Infrastructure database, 2018

It will be noted that when viewed annually, the value of committed investments varied significantly, with the values being less than US$20 billion in some years and more than US$ 100 billion in others. The highest number of projects embarked on was in 2012, with over 480 projects recorded. Overall, committed investments of a PPP nature in these countries exhibited an increasing trend over time but at the same time were very volatile from one year to the next.

Geographically, the database shows that the top three countries with the highest number of PPP projects over the period under review were China, India, and Brazil, which collectively accounted for over 57% of all projects.

Table 1: Cumulative Values and Number of Projects: PPP Investment in Developing Countries by Sector in 1997 – 2016

Sector	1997-2006		2007-2016	
	US$ Million	Number of Projects	US$ Million	Number of Projects
Transport Sector	**29 096.4**	**147**	**24 721**	**61**
Airports	2 660.2	14	413	6
Ports	9 611.6	46	4 970	25
Railways	3 584.6	7	10 812	10
Roads	13 240.0	80	8 526	20
Energy Sector	**31 754.3**	**957**	**30 840**	**370**
Electricity	28 115.3	779	30 023	334
Natural Gas	3 639.0	178	817	36
ICT	**12 585.6**	**6**	**436**	**1**
Water & Sanitation	**4 973.1**	**193**	**7 500**	**288**

Source: Data from World Bank's Private Participation in Infrastructure database, 2018

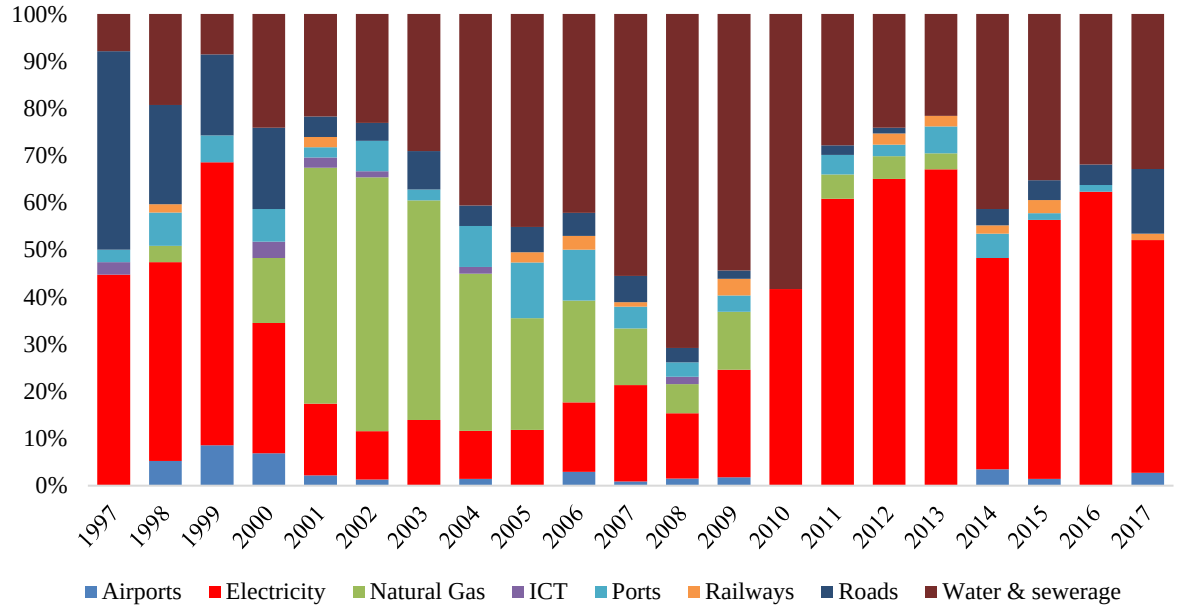
Table 1 shows that in developing countries, the energy sector attracted most PPP investment in the past two decades, with US$31 754 million invested during the period 1997-2006 and US$30 840 million in the period 2007-2016. The highest value of commitments and the highest number of projects were in the electricity sub-sector in both decades.

Transport was the sector which attracted the second highest value of PPP commitments. During the 1997-2006 period, investment in roads had the highest value of commitments, whilst PPP investment in railways dominated between 2007 and 2016.

The water and sanitation sector attracted the least value of PPP investment commitment, although the number of projects was the second highest, after the energy sector. Following this trend, Shediac, Hammami, Abouchakra, & Najjar (2008) concluded that it illustrated the

"public good" nature of the project. They argue that the provision of services to which the public had an inherent right, such as water, was considered a public good. As such, it proved less attractive to private investors because a public good has a low return on investment.

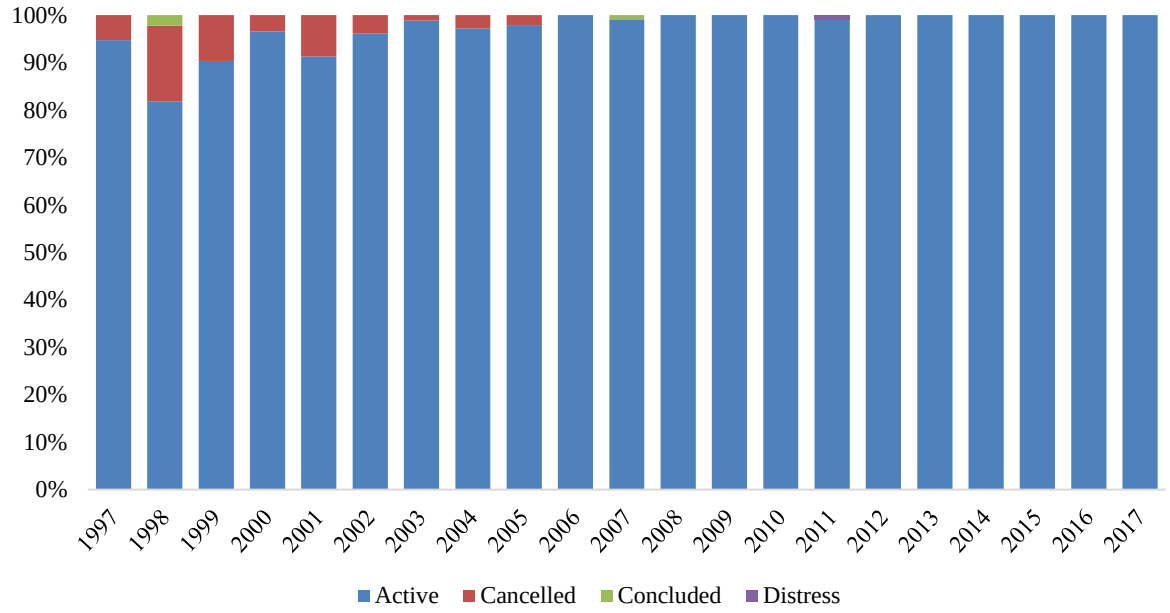
Figure 2: The Share of total Number of Projects by Year of Financial Closure



Source: Data from World Bank's Private Participation in Infrastructure database, 2018

The share in categories of the total number of projects varied somewhat over the period under assessment. However, at a glance, the highest share recorded was in the electricity and water and sewerage sector. On the other hand, the natural gas sector recorded notable shares between 2001 and 2004.

Figure 3: Status of PPP Projects by Year of Financial Closure



Source: Data from World Bank's Private Participation in Infrastructure database, 2018

Most infrastructure projects in this group of countries that had reached financial closure over the period under assessment were in an operational phase and very few projects had been cancelled. The share of cancelled projects was only recorded between 1997 and 2005. Similarly, the share of completed projects was significantly low and only recorded in 1998 and 2007.

2.3 Theoretical Framework of PPPs

In the late 20th Century, the concept of project financing had taken centre stage. This arose from the need to obtain financial resources with no recourse to fund infrastructure projects (Carbonara, Costantino, & Pellegrino, 2013). This means that the repayment of the project loans stemmed entirely from the cash flow generated by the project. Because of this, project financing using PPP models for the construction of facilities started to gain popularity.

To give more clarity to what a PPP model entails, it is a contractual agreement between the public sector and a private entity allowing for greater private sector participation in the delivery of public infrastructural projects (Deloitte Research, 2006; Kwak et al., 2009; Tang et al., 2010). The public sector entity could refer to a government department, a state-owned enterprise or a sub-regional level of government. More specifically, PPPs are a collaborative effort between governments and the private sector to provide infrastructure and services, traditionally delivered by the public sector.

Early debates around the role of infrastructure are more prominent in the classical development economics literature such as Hirschman (1957) and Nurkse (1952) who argued that high investment in infrastructure had a positive effect on development and that, given the large expenditures required in such investments, the government had to make provision for it. The theoretical linkages between public investment in infrastructure and economic growth dates back from the 1980s. However, many studies really emerged after the seminal work by Barro (1990). Barro found that raising public expenditure on infrastructure increased economic growth. Various later studies, including that of Abiad, Furceri, and Topalova (2016) found that the degree of the increase is influenced by several factors, including how efficient public investment was and how it was financed.

The model of the provision of infrastructure by the public sector has not been without challenges of which the most evident being the problem of under-investment due to under-pricing and poor service delivery, manifested by the lack of access to basic services. The establishment of the PPP model attempts to address these inefficiencies by combining the unique strengths of both the public and private sectors through the delivery of specific types of services or projects (Babatunde, Opawole, & Akinsiku, 2012).

Shediac et al. (2008) state that there are at least three ways in which PPPs can enhance economic growth. Firstly, they argue that enhancement is brought about by the number of projects that are underway. According to them, existing evidence suggests that a larger number of PPP project deals are associated with a higher GDP rate. They point out that countries with 70 or more PPP projects had a relatively higher GDP growth rate during the 1990 - 2003 period. Secondly, enhancement is determined by the country's economic and political policies as well as the strength of their institutions. The writers emphasise that PPPs are generally successful in countries that have established legislative frameworks that promote transparency as well as a competitive procurement process. Third and lastly, they argue that the value of the PPP projects provides the key to it all. The higher the value of the project, the more financial resources, and investment is injected into the economy. Based on their own analysis, Shediac et al. (2008) reported that a 1% increase in the value of PPP investment is likely to raise GDP per capita by 0.3%. This implies that the more countries increase the value of PPP investment, the more likely they are to see a noticeable increase in GDP per capita.

When establishing the framework of PPPs there are various role-players. These role-players, as well as the various factors they are subjected to (such as macroeconomic stability), are discussed below.

2.3.1 The role of government

The obvious economic justification for the involvement of government is to increase efficiency by aligning the incentives of the parties and enabling access to basic services at a lower cost than was the case under the traditional public delivery (Checherita, 2009). A government may use financial leverage tools such as guarantees, insurance policies, grants and tax exemptions to incentivise the participation of the private sector and to attract the interest of potential funders. Another widely cited reason for government involvement is the relaxation of the budget constraint by financing public infrastructure through private funding (Basilio, 2017; Checherita, 2009). Thus, it can be expected that governments with tight budget constraints, characterised by high public debt and a high tax burden (Checherita, 2009), will be more interested in fostering private sector involvement in PPPs to address their infrastructural needs. Empirical evidence is offered by Yehoue, Hammami, and Ruhashyankiko (2006) indicating that PPPs tend to be more common in countries where government have high debt burdens. Their research also makes some analyses of the cross-country and cross-industry determinants of PPP arrangements. This they do by using the World Bank's PPI database for developing countries during 1990-2003.

2.3.2 The role of private sector

The involvement of the private sector is not extensively analysed in the source material that is available. The most obvious one is that of profit-seeking as a motivation for involvement. The prime reason why the private sector finances infrastructure projects, is to obtain a return on their investment and generating a constant income stream for themselves. Most importantly, the private sector provides the necessary skills and management expertise that is required to operate and deliver public infrastructure more effectively over a certain period of time (Babatunde et al., 2012). However, the delivery of large infrastructure projects is inherently risky. Therefore, risk-sharing is one of the requirements cited for private sector involvement (Uzunkaya, 2017). The government has to take on the risks that it can control such as political risk, some legal and institutional risks as well as taking on the responsibility of cost overruns that may arise due to delays in the granting of permits. The government also has to take on risks that the private sector is not willing to take on, such as demand risk (Checherita, 2009).

2.3.3. Development Finance Agencies

Development Finance Institutions (DFIs) are important in providing funding for infrastructure projects. As highlighted by Basilio (2017) the involvement of DFIs does not only drive the developmental objective of the project but reduces the perception of risk to other agents.

More recently, funding from DFIs has also been used as a countercyclical instrument in the wake of the global financial crisis that may have constrained other traditional sources of long-term financing. In a study by Marcelo and House (2016) who examined the relationship between DFIs and contract cancellation in long term infrastructure PPPs, it was concluded that support from DFIs positively impacts on the performance of long-term PPP infrastructure contracts. The results of the study suggest that, without support from DFI, the cancellation rate for projects would have been 48% higher. Thus, it could be expected that the involvement of DFIs positively influences PPP projects.

2.3.4 Macroeconomic Stability and Market Conditions

Macroeconomic uncertainty does affect private investment negatively. The negative impact is brought about by unstable economic policies, high rate of inflation, low GDP growth and unstable exchange rates (Yehoue et al., 2006).

Generally, investment is attracted to countries with higher GDP growth rates and a higher degree of transparency when it comes to conducting business (Basilio, 2017). A high inflation rate is also viewed as being unfavourable for any private investor as it erodes the value of returns (Basilio, 2017). Generally, foreign capital is used to finance most infrastructure projects in developing countries. Therefore, a favourable exchange rate becomes an important factor when it comes to attracting private investors. Unexpected depreciation in the exchange rate can significantly affect the profitability of the project.

Market size and demand for services (purchasing power) are also important determinates for private sector participation in public infrastructure investment, more so when the project is financed by user fees (Basilio, 2017; Yehoue et al., 2006). Accordingly, PPPs tend to be more successful and profitable in markets with a high consumption rate.

2.4 Empirical Studies

There are a fair amount of sources that analyse the determinants for economic growth, many of which are based on an indigenous growth model theory (Barro, 1990; Button, 1998; Khan & Reinhart, 1990; Zangoueinezhad & Azar, 2014).

Infrastructure plays an important role in propelling a high standard of living and nurturing productive activity, all of which leads to higher economic growth. For example, Khan and Reinhart (1990) suggest that infrastructure projects, such as road, electricity, telecommunications, and energy, lead towards higher productivity and encourages private capital formation. These contribute to further economic growth.

Whilst the topic of the effect of private and public investment on economic growth to some extent, has been discussed in literature such as Barro (1990); Button (1998); Khan & Reinhart (1990) and Zangoueinezhad & Azar (2014), there is less extensive empirical literature available on how PPPs impact on economic growth. The first evidence-based attempt to analyse what role PPPs play in infrastructure projects was by Yehoue et al (2006) who used panel data techniques for the projects running in developing countries during 1990-2003. Their study found that PPPs tend to be successful in countries with large aggregate demand and market size.

Checherita (2009) analysed the determinates for investment relative to the GDP of developing countries on three levels (private, public and PPP). The study used data from the World Banks's PPI database. By examining the determinants for investment in PPP projects, the study found that countries that are more likely to implement larger PPP programmes were countries who already had experience with such programmes. The study also concluded that the share of PPP investment in GDP depended on the size of the economy which meant that the bigger the size of the economy, the larger the PPP programme is likely to be.

Checherita (2009) further assesses the determinants of PPPs but this time by using the total number of PPP projects as the dependent variable. He employs the negative binomial model, which takes into consideration the fact that the number of projects is count variables. Using this approach, he finds evidence on the determinants of PPP programmes to be inconclusive.

Lastly, Checherita (2009) models the impact of PPP investment using various variables, including the country's fiscal balance and its economic growth rate. In modelling the impact on its economic growth, he employs the convergence model and expands it to incorporate investment under PPP, which is considered as an additional type of capital formation. Using this method, he finds no evidence of the impact of PPP investment on economic growth.

Another empirical study that comes close to examining the effects of PPP investment on economic growth is found in Zangoueinezhad & Azar (2014) who investigated the links between the scale and nature of the PPP's contribution as propellers for economic growth. The study uses statistics causality modelling and other statistical techniques to model the causality of PPPs for economic growth in developing countries. Evidence suggests that PPP projects, either by number, value or type, are associated with higher GDP growth. They conclude that PPP projects bring capital into the market, thus creating long term employment. Higher employment leads to an increase in consumption and this leads to more wealth and a stronger economy.

Whilst their empirical methodology is not clearly outlined in their report, Shediac et al (2008) highlighted the fact that in countries where PPP projects have been 70 and more, such countries have demonstrated a comparatively higher GDP growth rate between the period 1990-2003. They also reported that a 1% increase in the value of PPP investment is likely to raise the GDP per capita by 0.3%.

Jasiukevicius and Vasiliauskaite (2013) shifts the focus from developing countries and examine the linkages between economic growth and PPP market development in EU countries. The authors use a combination of scientific literature and statistical data analyses to analyse the degree to which economic growth and the PPP market development indicators are related in EU countries. These indicators include the number and the value of PPP projects.[3] The results indicate that GDP growth responded positively to the development of the PPP market, if measured over a period of 20 years. However, the results varied notably across the countries that were analysed. For example, Belgium, Ireland, France and the United Kingdom (UK) were the only countries that showed a strong correlation between GDP growth and PPP market

[3] As outlined by the authors correlations were analysed by measuring the impact of nominal GDP growth on PPP market development by using different time lags of PPP market data.

development. Jasiukevicius and Vasiliauskaite (2013) also found that between the number of PPP projects and the capital costs of PPP, the relation between GDP growth and the number of PPP projects was much stronger than the relation with the capital costs of PPPs.

Another positive view on what infrastructure investment has on economic growth comes from Herranz-Loncán (2007) who analysed the impact that infrastructure investment (both public and private) had on Spanish economic growth for the period during 1850-1935. His estimate is based on a vector autoregressive (VAR) system which has been widely used to analyse the relationship between infrastructure investment and economic growth. This shows that the growth impact of infrastructure investment in Spain was positive, even though the returns on investment on large infrastructure networks were not all that high.

Other studies that have demonstrated a positive relationship between economic growth and private sector participation in infrastructure investment, mainly through the gains made in productivity and profitability include David Brown, Earle, and Telegdy, (2006), and La Porta and López-De-Silanes, (1999).

By contrast, there are other studies that argue that the involvement of the private sector in public infrastructure provision has failed to demonstrate positive effects because firms are mainly concerned with profits, price, and costs. Others again argue that by diverting resources to politically motivated projects, PPPs actually can harm growth.

Bayliss (2002) analysed the distributional impact of private sector participation by using empirical cases in the utility sectors of several developing countries, mostly in Africa and Latin America. He argues that private sector involvement has not benefited the poor and that in most cases, employment and income have either declined or access to basic services had fallen. Birdsall and Nellis (2003) also concluded that most of the privatisation programmes have contributed to worsening the distribution of income and assets, particularly in transitional economies, whilst Foster (2004) argues that earlier infrastructural reforms in Argentina have failed to take into account social concerns associated with the provision of basic services.

Hall (2015) again, argues that over the last 15 years or so, experience shows that PPPs have not worked. He claims that PPPs are expensive and ineffective in funding public infrastructure and divert government spending away from other public services. His analysis looks at the scale

of PPPs used and the institutions promoting them and the lessons that one could learn from it. In conclusion, he emphasises that the public sector is quite capable of using available financial resources to develop infrastructure and outsource the delivery of services to public sector entities. This will provide the public sector with various advantages such as flexibility, control and efficiency. A caveat on the Hall (2015) study is that it is not based on empirical evidence.

2.5 Chapter Summary

Generally, there seems to be a paucity of research on the relation between PPPs and their impact on economic growth in Africa. The focus of this study is therefore to examine the impact of PPPs investment on economic growth in developing countries in general.

Table 2: A Summary of Empirical Studies

Author (s)	Country (ies)	Sample Period	Main Findings
Zangoueinezhad & Azar (2014)	Brazil, China and India	1990 – 2009	The research investigates the relationship between the scale and nature of PPPs as drivers of economic growth. It uses statistics causality modelling and other statistical techniques to model the causality of PPPs used for economic growth in developing countries. The study finds that if PPPs are evaluated by the number of projects they are involved in, their value and type of project, an assumption can be made that they promote a higher rate of GDP growth over the long-term.
Yehoue et al (2006)	70 developing countries	1990 – 2003	Using panel data techniques, the study investigates the cross-country and cross-industry determinants of PPP arrangements between 1990-2003. It finds that PPPs tend to be more common in countries where the aggregate demand and market size is large.
Khan & Reinhard (1990)	24 developing countries	1970 – 1979	This study finds that private sector investment plays a much larger and thus, more important role in economic growth than does public investment. However, this finding only reflects on the direct effects of private and public investment on economies. Thus, it is possible that public investment has a positive indirect effect on growth.
Shediac et al (2008)	150 developing countries	1990 – 2003	Although the empirical methodology is not clearly outlined, the study finds that in countries where PPP projects have been 70 or more in number, such countries have demonstrated a comparatively higher GDP growth rate. Furthermore, it finds that a 1% increase in the value of PPP investment would likely raise GDP per capita by 0.3%.
Checherita (2009)	140 developing countries	1990 – 2005	Using a convergence growth model which he expands to include other types of investment, the author finds no evidence of a significant impact of PPP investment on economic growth.
Jasiukevicius & Vasiliauskaite (2013)	EU countries	1995 – 2011	The results indicate that taken over a 20-year period, GDP growth had responded positively to the development of a market for the PPP. However, the results varied notably across the countries that had been analysed. For example, Belgium, Ireland, France and the UK were the only countries that showed a strong correlation between GDP growth and PPP market development.

Source: Author's design from cited sources

CHAPTER THREE
METHODOLOGY

3.1 Introduction

In illustrating the effect of PPP investment on economic growth, the study adopts the typical convergence growth model (Barro, 1990; Bond, Temple, & Hoeffler, 2001; Checherita, 2009). The model is expanded by including an additional type of investment, namely gross capital formation (Checherita, 2009). Estimation is done through using a System Generalised Methods of Moments (GMM) for panel data. Blundell and Bond (1998) and Bond et al. (2001) advocates for a System GMM estimator for growth regressions as this would results in unbiased estimates and controls for endogeneity problems amongst variables.

This chapter is structured as follows:

- Section 3.2 outlines the data and sample period chosen in the study.
- Section 3.3 focuses on the regression equation and the description and measurement of the variables used in the model.
- Section 3.4 provides a detailed analysis of the estimation technique used in the model.

3.2 Sample Size and Data Period

The study will use the World Bank's Private Participation in Infrastructure (PPI) database.[4] PPIs are somewhat different from PPPs, however, Thomson (2005) argues that they often overlap resulting that the terms can be used interchangeably. The PPI database covers infrastructure projects in the energy, telecommunications, transportation and water sectors, dating as far back as 1993.

Out of roughly 118 countries classified as developing economies by the PPI database, 39 countries were selected (see **Table A1** in the Annexure) mainly because of the availability of infrastructure data. The sample period chosen is 1997 to 2016. This would ensure that there are sufficient data points for the panel to be as closely balanced as possible.

[4] The database covers contractual agreements for public infrastructure projects in low and middle income countries. The projects have also reached financial closure and private parties assume operating risks. Projects are not entirely privately owned, financed or operated; some projects have public participation as well. Lastly, investment amounts reflect the total investment commitment entered into by the project entity at contract signature or financial closure.

The study will consider two ways of capturing the prevalence of PPPs. First, it will use the US$ value of PPP investment. Secondly, PPP investment will be disaggregated into sectors, focussing on the energy, transport and water and sanitation sectors.

3.3 Analytical Framework

3.3.1 Regression Equation

With growth regressions, the problem of omitted variables that are related to the unobservable effects such as the initial level of technology often exists (Ding & Knight, 2009). Given this problem, there is a likelihood that the variations in technical efficiency across countries are correlated with explanatory variables. Consequently, this often results in estimates that are biased and inconsistent. As a result, the use of panel data techniques accounts for these unobserved country-specific effects (Ding & Knight, 2009). Furthermore, as Bond, Temple and Hoeffler (2001) emphasise, the inclusion of lags of regressors as instruments eliminate the problem of endogeneity associated with growth regression.

Adopted from Bond, et al (2001), the growth equation for our panel data model is as follows:

$$\Delta y_{i,t} = (\chi - 1) y_{i,t-1} + \chi'_{i,t}\beta + \mu_i + \epsilon_{i,t} \qquad i = 1\ldots, N \text{ and } t = 2\ldots, T$$

where $\Delta y_{i,t}$ is GDP per capita growth rate, $y_{i,t-1}$ is its lagged value, x_{it} is a vector of growth explanatory variables, μ_i is the country's specific fixed effect and $\epsilon_{i,t}$ is the error term. The above equation can be rewritten as follows, representing a dynamic panel data model, with a lagged dependent variable on the right-hand side:

$$y_{it} = \alpha\, y_{i,t-1} + x'_{it}\beta + \mu_i + \epsilon_{it} \qquad i = 1,,N \text{ and } t = 2,\ldots,T$$

Based on this equation, we first have to analyse the impact of PPP investment on economic growth (measured in GDP per capita growth in purchasing power parity prices) and we control for the roles that government, DFIs and the private sector play in PPP investments. Secondly, we shall consider the model in which the impact of PPP investment on economic growth is analysed in three different sectors in which PPP investments are made namely the energy[5],

5 Energy consists of electricity generation, transmission, and distribution; natural gas transmission and distribution.

water & sanitation and transport sectors.[6] Reflecting on these considerations, the following basic dynamic models are proposed:

$$GDPPC_{i,t} = \beta_1 GDPPC_{i,t-1} + \beta_2 PPP_{i,t} + \beta_3 GCF_{i,t} + \beta_4 PoP_{i,t} + \beta_5 INF_{i,t} + \beta_6 M3_{i,t} + \beta_7 GovRev_{i,t} + \beta_8 CrExt_{i,t} + \mu_i + \varepsilon_{i,t} \quad \textbf{(Eq. 1)}$$

Where i and t denotes country and year respectively; $GDPPC$ is the GDP per capita growth rate, PPP investments are in US$; GCF denotes gross capital formation, PoP is population growth rate, INF represents inflation rate, $M3$ is broad money supply, $GovRev$ is government revenue and $CrExt$ credit extension to the private sector. μ_i and $\varepsilon_{i,t}$ respectively, refer to the country's fixed effects and the error term. The definition, sources, and measurement of the variables are described in Table 3.

The distribution of PPP investments into energy (PPP_E), water and sanitation (PPP_WS) and transportation sectors (PPP_TR) are used to formulate equations 2, 3 and 4 respectively. This is done to identify the most productive sectors for PPP investments.

$$GDPPC_{i,t} = \beta_1 GDPPC_{i,t-1} + \beta_2 PPP\_E_{i,t} + \beta_3 GCF_{i,t} + \beta_4 PoP_{i,t} + \beta_5 INF_{i,t} + \beta_6 M3_{i,t} + \beta_7 GovRev_{i,t} + \beta_8 CrExt_{i,t} + \mu_i + \varepsilon_{i,t} \quad \textbf{(Eq. 2)}$$

$$GDPPC_{i,t} = \beta_1 GDPPC_{i,t-1} + \beta_2 PPP\_WS_{i,t} + \beta_3 GCF_{i,t} + \beta_4 PoP_{i,t} + \beta_5 INF_{i,t} + \beta_6 M3_{i,t} + \beta_7 GovRev_{i,t} + \beta_8 CrExt_{i,t} + \mu_i + \varepsilon_{i,t} \quad \textbf{(Eq. 3)}$$

$$GDPPC_{i,t} = \beta_1 GDPPC_{i,t-1} + \beta_2 PPP\_TR_{i,t} + \beta_3 GCF_{i,t} + \beta_4 PoP_{i,t} + \beta_5 INF_{i,t} + \beta_6 M3_{i,t} + \beta_7 GovRev_{i,t} + \beta_8 CrExt_{i,t} + \mu_i + \varepsilon_{i,t} \quad \textbf{(Eq. 4)}$$

[6] The sectors were chosen based on the fact that they are the largest sectors under PPP investment and data is availability.

3.3.2 Description and Measurement of Variables in the Regression Model

As mentioned previously, in the convergence growth model, output per worker depends on the initial value of GDP per capita, investment (in this case, investment is expanded to include PPP investment and gross fixed capital formation) and population growth (measured as working-age population). Furthermore, the model is expanded to include other control variables.

Section 2.1 tells us that the role of government is considered important in PPP investment. Amongst other things, the reason given for government's involvement is to relax its budget constraint through private financing of the public infrastructure. As such, government revenue reflected as a percentage of the GDP will be used (Checherita, 2009).

The role of the private sector will be proxied by credit extension to the private sector, reflected as a percentage of the GDP. This variable will be representative of resources channelled to the private sector (Kodongo & Ojah, 2016).

Finally, multilateral institutions, including DFIs, also play a role in PPP investment as they provide financial support through lending, equity contributions and the issuance of financial guarantee products. As financial intermediaries, DFIs also strengthen economic efficiency and growth by assisting in the allocation of capital to the best users (Kodongo & Ojah, 2016). To measure the involvement of DFIs, broad money supply is used as a proxy for DFIs (Kodongo & Ojai, (2016).

Table 3: Summary of Proposed Variable Description

Variable Name	Abbreviation	Unit of Measurement	Definition	Data Source
Dependent variable				
GDPPC	GDPPC	Per cent	GDP per capita based on purchasing power parity (PPP). Data used are in constant 2011 international dollars.	World Bank's World Development Indicators database
PPP Variables				
PPP investment	PPP	US$	Investment on contractual arrangements for public infrastructure projects that have reached financial closure. Private sector assumes operating risks.	World Bank's Private Participation in Infrastructure database
PPP in Energy Sector	PPP_E	US$	Energy sector includes infrastructure investment in electricity generation, transmission and distribution as well as natural gas transmission and distribution.	World Bank's Private Participation in Infrastructure database
PPP in Water and Sanitation Sector	PPP_WS	US$	Water includes investment in portable water generation and distribution, sewerage collection and treatment.	World Bank's Private Participation in Infrastructure database
PPP in Transport	PPP_TR	US$	Transport includes airport runways and terminals, railways, toll roads, bridges, highways and tunnels, port infrastructure, superstructures, terminals and channels.	World Bank's Private Participation in Infrastructure database
Control Variables				
Gross Capital formation	GCF	Per cent of GDP	This was previously known as gross domestic investment. It includes expenditure on fixed assets of the economy plus net changes in inventory levels. Fixed assets include land improvements, plant machinery and equipment purchases.	World Bank's World Development Indicators database
Population growth	PoP	Per cent	Annual population growth rate. Population includes all residents regardless of legal status or citizenship.	World Bank's World Development Indicators database
Broad money supply	M3	Per cent of GDP	Broad money is currency found outside banks and demand deposits but not central government deposits.	World Bank's World Development Indicators database
Government Revenue	GovRev	Per cent of GDP	Government revenue consists of taxes, social contributions, grants receivable and other revenue.	International Monetary Fund's World Economic Outlook data base
Inflation	Infl	Percent, year on year	Annual percentages of average consumer prices, based on year-on-year changes.	International Monetary Fund's World Economic Outlook data base
Credit extension to private sector	CrExt	Per cent of GDP	This refers to credit provided to the private sector such as financial resources provided by financial corporations.	World Bank's World Development Indicators database

Source: The World Bank and IMF, 2018.

3.4 Estimation Technique

By estimating growth models through the use of panel data, various studies have adopted first-differenced GMM. This was first applied by, amongst others, Holtz-Eakin, Newey and Harvey (1988). However, Blundell and Bond (1998) propose a system GMM estimator. Bond et al. (2001) go further and compare the first-differenced GMM estimator with a system GMM estimator in a Solow growth framework. They criticise the former estimator on the basis that with the empirical growth model, first-differenced GMM estimator may worsen endogeneity problem associated with growth models. Instead, they endorse a system GMM as a more efficient estimator and one that can be applied to dynamic panel data models. Bond et al (2001) argue that the system GMM estimator is far more plausible than other estimators when it comes to dynamic panel data models. This would lead to making unbiased estimates because it accounts for unobserved country-specific effects and using instrumental variables (IVs) which controls for endogeneity in growth models. They emphasise that even in the presence of measurement error, IVs allows for consistent estimation.

It must be pointed out that the system GMM technique has two main shortcomings, namely the proliferation of instruments of endogenous regressors and the serial autocorrelations of errors (Labra & Torrecillas, 2018; Roodman, 2009). Instrument proliferation occurs when there is a higher level of instruments which leads to overidentification of the model. Further, the dynamic panel method requires that errors are not serially correlated. If errors are serially correlated, this would imply that the instruments used are not valid (Cameron & Trivedi, 2009).

Whilst no accurate guidance is given on what an appropriate safe number of instruments is, Roodman (2009) proposes mechanisms to test for the existence of excess instruments through the Sargan and Hansen tests. In addition, the general rule of thumb is that the number of instruments should not exceed the number of groups (countries) in the model (Labra & Torrecillas, 2018). With system GMM, Sargan and Hansen are available directly when the xtabond2 command is used. The Sargan test verifies the validity of the instruments used in the model (Roodman, 2009). The null hypothesis of the test is set up as ‘over-identification in the model exists’. If the probability is higher than 5%, no evidence is available that would reject the null hypothesis, meaning that the used instruments in the estimations are valid. Thus, there would be no over-identification in the model. Labra and Torrecillas (2018) add that if the probability is close to 1, it does not imply that the instruments are valid, but rather that the

asymptotic properties of the test have not been applied. Similarly, the null hypothesis for the Hansen test says that "all restrictions of identification are valid" meaning that over-identification does exist. Rejection of the null hypothesis when the probability value is more than 5%, implies that the used instruments are valid.

In order to identify whether serial correlation exists amongst the errors, the Arellano and Bond (1991) Second Order Autocorrelation (AR2) test is used. As with the Sargan and Hansen, the Arellano and Bond test is available directly when using the xtabond2 command. The null hypothesis is set up as "Autocorrelation exist amongst the error terms". If the probability of the AR2 test is not significant, it means that there is no serial correlation amongst the residuals.

CHAPTER FOUR
DISCUSSION OF FINDINGS

4.1 Introduction

This chapter outlines the results produced by the estimated models and is structured as follows:

- Sections 4.2 presents the descriptive analysis of the model variables.
- Section 4.3 discusses the results of the estimated effect of PPP investment on economic growth.

The results are presented for both the total PPP investment and PPP distribution in the energy, transport and water and sanitation sectors.

4.2 Descriptive Statistics

Table 4 below summarises descriptive statistics of variables used in the model. The analysis of the data shows that all variables in the model have outliers. For this reason, the outliers have been winsorized as follows. Total PPP investment, PPP investment in the energy, transport and water, and sanitation sectors, broad money supply, credit extension to the private sector, inflation, and population growth have all been winsorized at 10% percentile. GDP per capita, government revenue, and gross capital formation were winsorized at 5% percentile.

Table 4: Summary of Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP per capita growth rate	780	2.9	2.8	-2.7	8.1
PPP investment (US$ million)	487	909.6	996.1	40.3	3092.3
PPP investment in energy sector (US$ million)	372	652.5	666.1	37.0	1935.7
PPP investment in water & sanitation sector (US$ million)	121	329.5	340.5	16.4	991.7
PPP investment in transport sector (US$ million)	211	425.1	401.5	23.4	1195.3
Gross capital formation (% of GDP)	780	23.1	6.5	14.9	39.1
Population growth rate	780	1.5	0.7	0.2	2.7
Government revenue (% of GDP)	763	22.6	7.6	11.2	36.2
Inflation rate	775	6.0	3.6	1.3	12.7
Broad money supply (% of GDP)	755	55.6	28.2	22.3	112.6
Credit extension to private sector (% of GDP)	768	43.0	28.3	12.3	101.8

Source: Author's calculation.; *Note: Std. Dev = Standard deviation, Obs = Observation, Min = Minimum and Max = Maximum*

On average, developing countries sampled for this study spend over US$900 million on PPP investment as shown by the mean of the PPP variable. The minimum and maximum values lie between US$40 million and US$3 092 million. When disaggregated by sectors, expenditure on energy, water and sanitation, and transport averaged US$652 million, US$329 million and US$425 million respectively. This indicates that the energy sector is the most attractive for PPPs in developing economies.

Gross capital formation as a percentage of the GDP averaged 23.1%, whilst population growth, government revenue as a percentage of GDP and inflation, averaged 1.5%, 22.6%, and 6%, respectively. The average credit extension to private sector stands at 43% which suggests that a noticeable amount of financial resources is channelled to the private sector. Broad money supply as a percentage of the GDP averaged 55.6%, with the minimum value being 22.3% and the maximum 112.3%.

Table 5: Correlation Matrix

Variables	1	2	3	4	5	6	7	8	9	10	11
1 GDPPC	1										
2 PPP	0.065	1									
3 PPP_E	0.043	0.874**	1								
4 PPP_WS	0.054	0.335**	0.338**	1							
5 PPP_TR	0.167***	0.692***	0.298**	0.237***	1						
6 GFC	0.501***	0.200***	0.136***	0.152	0.369**	1					
7 PoP	-0.195**	0.041	-0.035	0.208***	0.009	-0.708	1				
8 GovRev	-0.042	0.325**	0.289**	0.155	0.092	-0.039	-0.439	1			
9 Inf	-0.119***	-0.123***	-0.091	-0.112	-0.083	-0.230**	-0.042	0.001	1		
10 M3	0.170**	0.293**	0.292**	0.232***	0.225**	0.437**	-0.135***	0.143**	-0.397**	1	
11 CrExt	0.076	0.193**	0.146***	0.273**	0.191**	0.434**	-0.089*	0.184**	-0.413**	**0.860****	1

*Note: PPP=PPP investment (US$ million); PPP_E= PPP investment in energy sector (US$ million); PPP_WS=PPP investment in water & sanitation sector (US$ million); PPP_TR= PPP investment in transport sector (US$ million); GFC=Gross capital formation (% of GDP); PoP=Population growth rate; GovRev=Government revenue (% of GDP); Inf=Inflation rate; M3=Broad money supply (% of GDP); CrExt=Credit extension to private sector (% of GDP). Source: Author's calculation; *p>0.1, **p>0.01, ***p>0.05***.*

Table 5 illustrates the correlation matrix. The larger the absolute value of the coefficient, the stronger the relationship between the variables. A larger value implies that multicollinearity between variables exits which means that the variables in the regression model are highly correlated. As a rule of thumb, it can be taken that anything below 0.7 is generally acceptable. Anything above 0.8 in absolute terms will be regarded as high (Kennedy, 1993). Variables that seem to be highly correlated are PPP investment in general and PPP investment in energy. The estimated coefficient between credit extension to the private sector and broad money supply

indicates a high level of association. Hence, the two variables have not been included in the same estimation, but rather reflected in a stepwise manner.

4.3 Regression Results

Table 6 and 7 illustrate the results of the equations estimated. It is observed that the number of groups is greater than the number of instruments used on all occasions. Furthermore, all models have passed the Sargan, Hansen, and AR (2) tests avoiding over-identification of instruments in the model. This indicates that the instruments used are valid when explaining the impact of PPP investment on economic growth.

Table 6 shows the results of the estimated effects PPP investment has on the economic growth of the selected developing countries (Equation 1). Due to the observed strong collinearity between credit extension to the private sector and broad money supply, two different models are estimated. The results in column (a) include all other independent variables except the credit extension to the private sector while column (b) includes all other independent variables except the broad money supply variable.[7]

The positive coefficients of PPP investment in both column (a) and (b) imply that PPPs contribute positively to economic growth at a 10% level of significance. This finding is in line with Zangoueinezhad and Azar (2014) and Shediac et al (2008) who found that PPP investments are associated with a higher rate of GDP growth.

Gross capital formation, which is a variable that measures investment other than PPPs have been found to be insignificant in explaining economic growth. This result is similar to the findings of Checherita (2009). He found that investment (other than PPPs) in seven Latin American countries over the period 1990-2001 was not significant enough to explain economic growth. He associates this finding with the fact that it may be difficult for investment to unveil growth effects over a relatively short period of time.

[7] In all models used in this study, other estimation techniques such as differenced GMM, OLS and Fixed Effects (least square dummy variable) models were also attempted. However, they did not satisfy the standard requirements of credible models.

Table 6: Results of the Impact of PPP Investment of Economic Growth in Selected Developing Countries

	System GMM	
	(a)	**(b)**
GDPPC L1	0.7895**	0.7510**
Ln_PPP	0.7704*	0.8282*
Ln_GFC	-1.8528	-1.6303
Ln_GovRev	-1.5281***	-1.6103***
PoP	-0.2283	-0.3031
Inf	-0.1275***	-0.1140***
Ln_M3	-0.5926	-
Ln_CrExt	-	-0.5507*
Cons	9.7561***	8.7727***
AR (1): p-value	0.000	0.000
AR (2): p-value	0.572	0.636
Sargan test: p-value	0.89	0.827
Hansen test: p-value	0.872	0.816
No. of instruments	23	23
Countries	39	39
Observations	489	499

Note: Ln= log of variables. PPP=PPP investment (US$ million); PPP_E= PPP investment in energy sector (US$ million); PPP_WS=PPP investment in water & sanitation sector (US$ million); PPP_TR= PPP investment in transport sector (US$ million); GFC=Gross capital formation (% of GDP); PoP=Population growth rate; GovRev=Government revenue (% of GDP); Inf=Inflation rate; M3=Broad money supply (% of GDP); CrExt=Credit extension to private sector (% of GDP). GMM = Generalised Methods of Moments.,. p>0.1, p>0.01**, p>0.05*** Source: Author's calculation*;

Government revenue and the inflation rate in column (a) and (b) exhibit a negative relationship with economic growth and are statistically significant at 5%. Government revenue which is a proxy for higher tax burdens, suggests that the higher the tax burden, the more difficult it may be for government to raise taxes further in order to cover bulk expenditure that likely contributes to economic growth such as infrastructure investment (Checherita, 2009). Inflation is as expected, negatively associated with economic growth as it erodes the value of money that could be spent on areas that contribute to GDP growth.

Contrary to expectations, credit extension to private sector in column (b) shows a negative relationship with economic growth. This is in line with various studies made, including Bayliss (2002), Birdsall and Nellis (2003) and Foster (2004) who argue that the involvement of the private sector in providing public infrastructure does not always demonstrate meaningful and positive effects on overall economic growth as the private sector in most cases is generally just concerned with profits, costs, and prices.

In this study, other variables that have been found insignificant in explaining economic growth are M3 and population growth.

4.3.1 Sectoral Effect of PPPs on Economic Growth

Table 7 illustrates the results of the estimated effects by sector of PPP investment on economic growth.[8] Due to data unavailability, 17 countries were dropped[9], decreasing the number of countries in the panel to 22. Model (a) includes all variables, except the credit extension to the private sector while model (b) includes this variable but excludes the broad money supply variable.

Table 7: Results of the Impact of Sector PPPs on Economic Growth

	Energy Sector (Eq.2)		Water & Sanitation Sector (Eq. 3)		Transport Sector (Eq. 4)	
	(a)	**(b)**	**(a)**	**(b)**	**(a)**	**(b)**
GDPPC L1	0.2687*	0.2721***	0.4462	0.5513	-0.4863	-0.3162
Ln_PPP_E	-0.9005*	-0.8079*				
Ln_PPP_WS			0.0805	0.0879		
Ln_PPP_TR					-2.5337*	-2.4721*
Ln_GFC	4.3219***	3.6672*	4.8913**	5.2971***	21.1159***	17.059*
Ln_GovRev	0.8875	0.7523	0.5902	1.0209	2.4926	2.1868
PoP	-0.0628	-0.3807	-0.6092	-0.5001	1.2184	0.6282
Inf	-0.1139*	-0.1417	-0.1281***	-0.1331*	-0.0935	-0.1083
Ln_M3	0.2404	-	0.4929	-	-1.8568	-
Ln_CrExt	-	-0.4699	-	-0.7417	-	-1.5484
Constant	-8.3480	-3.2040	-12.7786*	-15.1748*	-47.4606*	-35.5553
AR (1): p-value	0.003	0.003	0.251	0.231	0.058	0.046
AR (2): p-value	0.573	0.549	0.336	0.248	0.58	0.484
Sargan test: p-value	0.281	0.313	0.177	0.317	0.417	0.469
Hansen test: p-value	0.651	0.567	0.503	0.283	0.787	0.851
No. of instruments	21	21	14	14	14	14
Countries	22	22	13	14	22	22
Observations	263	271	93	94	196	199

Note: PPP=PPP investment (US$ million); PPP_E= PPP investment in energy sector (US$ million); PPP_WS=PPP investment in water & sanitation sector (US$ million); PPP_TR= PPP investment in transport sector (US$ million); GFC=Gross capital formation (% of GDP); PoP=Population growth rate; GovRev=Government revenue (% of GDP); Inf=Inflation rate; M3=Broad money supply (% of GDP); CrExt=Credit extension to private sector (% of GDP). , Ln=log of variables,. p>0.1, p>0.01**, p>0.05***. Source: Author's calculation;*

[8] The model for the distribution of PPP investment into sectors was initially run with all sectors combined. However, the inconsistent availability of data across countries and sectors reduced the number of observations significantly, resulting in the number of instruments exceeding the number of groups in the model which violates the validity of the regression estimates. Therefore, impact of PPP investment by sectors was estimated individually for each sector as outlined in equations 2, 3 and 4.

[9] These countries are: Algeria, Bolivia, Cambodia, Egypt, Gabon, Guatemala, Honduras, Morocco, Nepal, Nigeria, Tanzania, Tunisia, Uganda, Ukraine, Kenya, Jordan and Romania.

Contrary to expectations, the results show that out of the sampled group of developing countries, none of the selected sectors contributed positively to economic growth. In both model (a) and (b), PPPs in the energy and transportation sectors exhibit a negative relationship with economic growth, whilst PPP investment in water and sanitation is not statistically significant in explaining economic growth. This finding runs contrary to many studies that had found that infrastructure investment, at least in the energy and transport sectors, contributes positively to economic growth. In reviewing a sample of studies that have empirically looked at the impact of infrastructure on economic growth in developing countries, Estache and Garsous (2012a) highlight that a number of studies have found infrastructure investment in energy, telecommunication and transport to be the most productive and hence have a higher impact on economic growth. In their report, Shediac, et al (2008) maintain that PPP investment in the energy and transport sectors attract a large share of investment because the returns on investment and commercial considerations are high. As a result, their relationship with economic growth is often positive.

Estache and Garsous (2012a) again, highlight the fact that time dimension plays a critical role in carrying out infrastructure investment studies (whether they be PPPs or traditional infrastructure investment). All things being constant, studies that cover long periods of time are more likely to show a positive impact of infrastructure investment on growth and output. The reason for this is that infrastructure generally, has a unique cash flow profile that has high short-term costs and a slow but long-term income flow. Investments in the energy and transport sectors are often built on revenue forecasts with over 30 years of lead time.[10]

Indeed, the time dimension in this study could well be what had resulted in the inconsistent results in comparison with prior studies that have assessed the impact of PPPs on sector economic growth. Add to that, the results could also have been influenced by poor data availability when PPP investment is allocated to a specific sector. Chechrita (2009) highlights the fact that, because some projects by sector are not included in the PPI database because they are initiated by the local sphere of government and thus are not publicly available, they are likely to be excluded from the database. This results in uneven data availability.

[10] Naturally, the time dimension factor should also hold for aggregate PPP investment. The fact that it does not hold, could be attributed to more observations and data points that could have worked in aggregate PPP investment's favour. With PPP sectors, a few observations were excluded due to data challenges.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATION

5.1 Introduction

Chapter five summarises the main findings of the study as well as the implications thereof. It also highlights how future studies of this nature can be improved. Sections 5.2 provides a summary of the study and this is followed by a summary of findings and implications in Section 5.3. The two last sections outline the recommendations based on the findings of the study while also highlighting the limitations of the study. Proposals for future research are made to overcome these limitations.

5.2 Summary of the Study

Governments, particularly in developing countries, are continuously faced with the challenge of expanding infrastructure to keep up with population growth and rapid urbanisation. This challenge arises from the fact that public resources are strained as governments face high budget deficits and rising debt to GDP ratios. At the same time, development institutions alone have not succeeded in narrowing this gap. As a result, governments have resorted to sourcing private sector funding in order to expand public infrastructure. This is generally done in a form of PPPs. Whilst the use of PPPs is a growing trend in developing countries, there are, unfortunately, not many empirical studies that have assessed the impact of PPP investment on economic growth on a whole.

In the absence of such studies, this study investigated the effects of PPP investment on economic growth in various developing countries. The study carries out this analysis in two ways. First, it analyses total PPP investment in value terms and how that affect economic growth, measured in GDP per capita. Secondly, the study disaggregates PPP investment by sector, focusing on the three most popular PPP sectors – energy, transport, and water & sanitation – and examine which PPP sectors have the strongest influence on economic growth.

5.3 Findings and Implications

The results in this study show that when controlling for the government's tax burden, population growth, and private sector involvement, PPP investment positively contributes to economic growth. The finding is consistent with the studies by Zangoueinezhad and Azar (2014) and

Shediac, et al (2008) who found that PPP investments are indeed associated with a higher rate of economic growth.

When disaggregating PPP investment by sector, the study finds that none of the selected sectors positively contribute to economic growth in the sampled developing countries. As far as sector investment is concerned, PPP investment in the energy and transport sectors were found to contribute negatively to growth while PPP in the water and sanitation sector was found to be insignificant when it comes to explaining economic growth. With regards to the water sector, Shediac et al. (2008) maintain that that projects designed for a higher degree of public good such as water are generally associated with lower returns because it is considered an essential resource that must be provided at affordable prices. The result is that these projects are less attractive for PPP investment.

The inconsistent results found in past empirical studies on investment in the energy and transportation sectors could be explained by Estache and Garsous' notion of time dimension which states that when carrying out empirical infrastructure studies, time period does play an important role when arriving at the results of the study. Studies that cover longer time periods are more likely to find a positive impact of infrastructure on both growth or output.

5.4 Recommendations

PPPs are becoming a necessary solution for strengthening infrastructure and generating economic growth in developing countries. As the case is with public investment, understanding the empirical links that exist between infrastructure investment using PPPs and economic growth or output, is becoming essential. However, the only way that studies of such nature will succeed, depends on the availability and credibility of data used to carry out empirical studies. In other words, data needs to be consistently available over a long period of time. How data is reported is also important as it affects the credibility of the model and the results produced by it. When the model and the results are credible, studies such as these could enhance debate in developing countries on how best to use PPP models as propellers for economic growth.

It is, therefore, recommended that those that are at the forefront of researching and providing PPP investment data, ensure that the availability of such data is improved and that the

shortcomings of inconsistency in the reporting thereof be corrected in order to ensure that meaningful and accurate conclusions could be drawn from it.

5.5 Limitations of the Study and Recommendations for Future Research

A major limitation of this study was to obtain adequate PPP investment data. In some cases, data was not recorded resulting in producing an unbalanced panel. Furthermore, the frequency of data was found to be inconsistent, particularly when it came to determining the value of PPP investment. Data also contained large outliers because investment values per country were significantly higher in one year and almost zero in the other.

Finally, and as the World Bank had reported, data is provided by public sources such as local or small-scale operators. Therefore, such data may be omitted or may not always be accurate in order to provide the information required by researchers.

The implication thereof is that the results could have been influenced by the challenges facing data collection. However, if the data shortcomings are corrected and the availability thereof is improved, some areas of PPP investment research can in future be expanded. Firstly, the impact on the level of income and growth on development in sample countries could then be analysed. Secondly, the disaggregation of PPP investment by sector could be expanded to the level of subsectors. It would then be possible to analyse which of such subsectors (i.e. electricity, natural gas or renewable energy) are the most productive. Lastly, another area that could be explored is by differentiating PPP investment from the type of project in which investment is made. In other words, analysing the different types of projects. For example, management and lease contracts, greenfield and brownfield projects could be analysed in order to find out which of them had the most impact on economic growth.

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ANNEXURE

Table A 1: List of Panel Countries and Region

Country	Region
Algeria	Middle East and North Africa
Argentina	Latin America and the Caribbean
Bangladesh	South Asia
Bolivia	Latin America and the Caribbean
Brazil	Latin America and the Caribbean
Bulgaria	Europe and Central Asia
Cambodia	East Asia and Pacific
China	South Asia
Colombia	Latin America and the Caribbean
Costa Rica	Latin America and the Caribbean
Dominican Republic	Latin America and the Caribbean
Egypt	Middle East and North Africa
Gabon	Sub-Saharan Africa
Guatemala	Latin America and the Caribbean
Honduras	Latin America and the Caribbean
India	South Asia
Indonesia	East Asia and Pacific
Jordan	Middle East and North Africa
Kenya	Sub-Saharan Africa
Malaysia	East Asia and Pacific
Mexico	Latin America and the Caribbean
Morocco	Middle East and North Africa
Nepal	South Asia
Nigeria	Sub-Saharan Africa
Pakistan	South Asia
Panama	Latin America and the Caribbean
Peru	Latin America and the Caribbean
Philippines	East Asia and Pacific
Romania	Europe and Central Asia
Russian Federation	Europe and Central Asia
South Africa	Sub-Saharan Africa
Sri Lanka	South Asia

Tanzania	Sub-Saharan Africa
Thailand	East Asia and Pacific
Turkey	Europe and Central Asia
Tunisia	Middle East and North Africa
Uganda	Sub-Saharan Africa
Ukraine	Europe and Central Asia
Vietnam	East Asia and Pacific

Source: PPI Database, 2018

Table A 2: Stata Results for Model (a)

```
Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: countrynum                      Number of obs      =       489
Time variable : yr                              Number of groups   =        39
Number of instruments = 23                      Obs per group: min =         5
Wald chi2(7)  =    160.96                                      avg =     12.54
Prob > chi2   =     0.000                                      max =        19
------------------------------------------------------------------------------
             |               Robust
       gdppc |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       gdppc |
         L1. |   .7895302   .1004317     7.86   0.000     .5926876    .9863727
             |
      ln_ppp |   .7704137   .4477129     1.72   0.085    -.1070874    1.647915
      ln_gfc |   -1.85278   1.307505    -1.42   0.156    -4.415443    .7098826
   ln_govrev |  -1.528074    .765898    -2.00   0.046    -3.029206   -.0269413
       pop_r |  -.2283823    .293599    -0.78   0.437    -.8038259    .3470612
         inf |  -.1275477   .0542539    -2.35   0.019    -.2338834    -.021212
        ln_m3 |  -.5926018   .4301547    -1.38   0.168    -1.435689    .2504859
       _cons |   9.756079   4.232759     2.30   0.021     1.460023    18.05213
------------------------------------------------------------------------------
```

Table A 3: Stata Results for Model (b)

```
Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: countrynum                      Number of obs      =       499
Time variable : yr                              Number of groups   =        39
Number of instruments = 23                      Obs per group: min =         5
Wald chi2(7)  =    149.55                                      avg =     12.79
Prob > chi2   =     0.000                                      max =        19
------------------------------------------------------------------------------
             |               Robust
       gdppc |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       gdppc |
         L1. |   .7509854   .1023071     7.34   0.000     .5504673    .9515036
             |
      ln_ppp |   .8281794   .4771308     1.74   0.083    -.1069797    1.763338
      ln_gfc |  -1.630314   1.185354    -1.38   0.169    -3.953566    .6929379
   ln_govrev |  -1.610334   .8181128    -1.97   0.049    -3.213806   -.0068624
       pop_r |  -.3031395   .3002011    -1.01   0.313     -.891523    .2852439
         inf |  -.1140254   .0527235    -2.16   0.031    -.2173615   -.0106893
       ln_c_ext |  -.5507392   .2916513    -1.89   0.059    -1.122365    .0208869
       _cons |    8.77267   3.894777     2.25   0.024     1.139049    16.40629
------------------------------------------------------------------------------
```

Table A 4: Stata Results for PPP Energy Sector (Eq. 2 – Model (a))

```
Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: countrynum                      Number of obs      =       263
Time variable : yr                              Number of groups   =        22
Number of instruments = 21                      Obs per group: min =         5
Wald chi2(7)  =     48.99                                      avg =     11.95
Prob > chi2   =     0.000                                      max =        19
------------------------------------------------------------------------------
             |               Robust
       gdppc |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       gdppc |
         L1. |   .2686707   .1410893     1.90   0.057    -.0078591    .5452006
             |
    ln_ene_s |  -.9005448      .4447    -2.03   0.043    -1.772141   -.0289487
      ln_inv |   4.321997   2.113467     2.04   0.041     .1796778    8.464315
         inf |  -.1139254   .0612255    -1.86   0.063    -.2339252    .0060745
   ln_govrev |   .8875262   .9783176     0.91   0.364    -1.029941    2.804993
       pop_r |  -.0628254   .5277019    -0.12   0.905    -1.097102    .9714514
       ln_m3 |   .2404786   .6301961     0.38   0.703    -.9946831     1.47564
       _cons |  -8.348038   6.641955    -1.26   0.209    -21.36603    4.669955
------------------------------------------------------------------------------
```

Table A 5: Stata Results for PPP Energy (Eq.2 – Model (b))

```
Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: countrynum                      Number of obs      =       271
Time variable : yr                              Number of groups   =        22
Number of instruments = 21                      Obs per group: min =         8
Wald chi2(7)  =     47.40                                      avg =     12.32
Prob > chi2   =     0.000                                      max =        19
------------------------------------------------------------------------------
             |               Robust
       gdppc |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       gdppc |
         L1. |   .2721483   .1270967     2.14   0.032     .0230433    .5212534
             |
    ln_ene_s |  -.8078913   .4246694    -1.90   0.057    -1.640228    .0244454
      ln_inv |    3.66722   1.925008     1.91   0.057    -.1057259    7.440166
         inf |  -.1417399   .0641664    -2.21   0.027    -.2675038    -.015976
   ln_govrev |   .7523252   .8374852     0.90   0.369    -.8891156    2.393766
       pop_r |  -.3807299   .4586001    -0.83   0.406     -1.27957    .5181098
    ln_c_ext |  -.4698688   .4681583    -1.00   0.316    -1.387442    .4477045
       _cons |  -3.204066   6.098077    -0.53   0.599    -15.15608    8.747946
------------------------------------------------------------------------------
```

Table A 6: Stata Results for PPP Water and Sanitation Sector (Eq.3 – Model (a))

```
Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: countrynum                      Number of obs      =        93
Time variable : yr                              Number of groups   =        13
Number of instruments = 14                      Obs per group: min =         1
Wald chi2(7)  =    594.90                                      avg =      7.15
Prob > chi2   =     0.000                                      max =        19
------------------------------------------------------------------------------
             |               Robust
       gdppc |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       gdppc |
         L1. |     .44622   .3357549     1.33   0.184    -.2118476    1.104287
             |
     ln_ws_s |   .0805304   .1973846     0.41   0.683    -.3063362    .4673971
   ln_govrev |   .5902339   1.621541     0.36   0.716    -2.587929    3.768397
      ln_gfc |   4.891268   1.592119     3.07   0.002     1.770771    8.011764
       pop_r |  -.6092325   1.290569    -0.47   0.637    -3.138702    1.920237
         inf |  -.1281329   .0647441    -1.98   0.048     -.255029   -.0012368
       ln_m3 |  -.4929883   1.110357    -0.44   0.657    -2.669247     1.68327
       _cons |  -12.77855   7.161154    -1.78   0.074    -26.81415    1.257052
------------------------------------------------------------------------------
```

Table A 7: Stata Results for PPP Water and Sanitation Sector (Eq.3 – Model (b))

Dynamic panel-data estimation, one-step system GMM

Group variable: countrynum			Number of obs	=	94
Time variable : yr			Number of groups	=	14
Number of instruments = 14			Obs per group: min	=	1
Wald chi2(7) = 353.30			avg	=	6.71
Prob > chi2 = 0.000			max	=	19

gdppc	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
gdppc L1.	.5512546	.403966	1.36	0.172	-.2405043	1.343013
ln_ws_s	.08789	.2213399	0.40	0.691	-.3459281	.5217082
ln_govrev	1.020858	1.769338	0.58	0.564	-2.446982	4.488697
ln_gfc	5.297136	2.087748	2.54	0.011	1.205225	9.389048
pop_r	-.500191	1.209774	-0.41	0.679	-2.871304	1.870922
inf	-.1331217	.0704336	-1.89	0.059	-.2711689	.0049256
ln_c_ext	-.7416682	1.201231	-0.62	0.537	-3.096038	1.612702
_cons	-15.17484	8.425234	-1.80	0.072	-31.688	1.338317

Table A 8: Stata Results for PPP Transport Sector (Eq. 4 – Model (a))

Dynamic panel-data estimation, one-step system GMM

Group variable: countrynum			Number of obs	=	196
Time variable : yr			Number of groups	=	22
Number of instruments = 14			Obs per group: min	=	1
Wald chi2(7) = 11.97			avg	=	8.91
Prob > chi2 = 0.102			max	=	19

gdppc	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
gdppc L1.	-.4862972	.5514957	-0.88	0.378	-1.567209	.5946145
ln_trans_s	-2.533663	1.477466	-1.71	0.086	-5.429443	.3621169
ln_govrev	2.492616	2.450867	1.02	0.309	-2.310995	7.296226
ln_gfc	21.11593	10.38811	2.03	0.042	.7556035	41.47626
pop_r	1.218358	1.348937	0.90	0.366	-1.42551	3.862226
inf	-.0934595	.1375361	-0.68	0.497	-.3630254	.1761063
ln_m3	-1.856788	1.656265	-1.12	0.262	-5.103009	1.389432
_cons	-47.46063	25.30534	-1.88	0.061	-97.05819	2.136925

Table A 9: Stata Results for PPP Transport Sector (Eq. 4 – Model (b))

Dynamic panel-data estimation, one-step system GMM

Group variable: countrynum			Number of obs	=	199
Time variable : yr			Number of groups	=	22
Number of instruments = 14			Obs per group: min	=	1
Wald chi2(7) = 8.69			avg	=	9.05
Prob > chi2 = 0.275			max	=	19

gdppc	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
gdppc L1.	-.3162208	.4886905	-0.65	0.518	-1.274037	.641595
ln_trans_s	-2.472106	1.311412	-1.89	0.059	-5.042427	.0982153
ln_govrev	2.186754	2.383932	0.92	0.359	-2.485666	6.859175
ln_gfc	17.059	8.746344	1.95	0.051	-.0835236	34.20151
pop_r	.6282401	1.326954	0.47	0.636	-1.972541	3.229021
inf	-.1083216	.127048	-0.85	0.394	-.357331	.1406879
ln_c_ext	-1.548353	1.220484	-1.27	0.205	-3.940457	.8437518
_cons	-35.55535	23.04817	-1.54	0.123	-80.72893	9.61823